

PRESIDENT'S ADDRESS AND SUMMARY OF THE SOCIETY'S
WORK IN 1905.

(ADDRESS AT ANNUAL "AT HOME," JANUARY 1906.)

ASTRONOMICAL AND ASTROPHYSICAL PROGRESS IN 1905.

AFTER referring to the happy relations existing between the President and Council, to the Society's loss in the death of Larratt W. Smith, J. J. Wadsworth and Arthur Harvey,* and to the loss to the astronomical world abroad by the death of Paul Henry, Pietro Tacchini, Ralph Copeland and Walter F. Wislicenus, the address was as follows:—

THE OTTAWA OBSERVATORY.

The most important event in the history of Canadian Astronomy during 1905 was the completion of the Dominion Observatory, located on the Experimental Farm on the outskirts of Ottawa. The building is a beautiful one, constructed of gray stone with brown stone trimmings, and finished in polished oak. The chief instrument is a 15-inch equatorial refractor by Brashear, with mounting by Warner & Swasey. I am sure we all congratulate the Federal Government on the handsome official home for astronomy, and Dr. King on having such a splendid institution to preside over.

* For obituary notices see end of this volume; that of Arthur Harvey was given in last year's Transactions.

THE SUN.

The most interesting solar occurrence during the year was the total eclipse of August 30, and to us in Canada an event second only in importance to the establishment of the Dominion Observatory. In my address a year ago I explained the honorable part the Society had in initiating the expedition. In the name of our Council a memorial was sent to the Premier, calling attention to the approaching phenomenon and urging the despatching of an expedition. As most of you know, the path of the total phase began in Manitoba, crossed James Bay and Labrador, and then, in the Old World, passed over Spain, Algeria, Tunis, Tripoli, Egypt, ending in Arabia. Although the prospects for fair weather were better in Spain or Africa, yet we knew that those portions of the path would be well attended to, and so we urged that our expedition go to Labrador. Our proposal was received and acted upon in a generous spirit. I need not refer at length to what happened. The first portion of the expedition sailed from Quebec on August 4, and the second on August 21, all returning together and reaching Quebec on September 7. The most extensive portion of the equipment was that provided by the Dominion Observatory and under the immediate management of Mr. John S. Plaskett. It consisted of four cameras and three spectrographs. Instead of pointing these at the Sun, they were placed on rigid cement piers, and the rays of light reflected into them by a large cœlostæt. Next in importance was the outfit brought from the Royal Observatory at Greenwich by Mr. E. Walter Maunder, who, with his wife, had been invited by Sir Wilfrid Laurier to take part in the expedition. Two members of the British Astronomical Association, Messrs. Upton and Jennings, also accompanied the expedition and assisted Mr. Maunder. In addition there was a complete outfit for determining absolutely and for recording photographically the magnetic elements, and also for obtaining other meteorological data. This was sent out by Director Stupart, and was in charge of Mr. William Menzies. Instruments for finding the latitude and longitude of the station and for measuring the value of gravity, as well as numerous other telescopes, polariscopes, etc., were carried on the expedition. With great labor, but all performed with light hearts, the prepar-

ations were pushed forward, no obstacles such as frequent showers or the annoying black flies and mosquitoes being allowed to stop the work, until at last the installation was complete. After this were tedious adjustments and numerous rehearsals, until all was ready for the great event. But it was of no avail! On the morning of August 30 the sky was covered with heavy leaden clouds, and no observations, except of the weird darkness at the time of totality, were made. It is true the determinations of the magnetic elements, of the geographical position of the station and of the force of gravity are of considerable value, but we had hoped to write a bright page in the astronomical annals of Canada and were sorely disappointed. There was only one other station in America, namely, at Sandwich Bay on the Labrador, where the party from the Lick Observatory was located, and here there was no success. In Spain there were many parties. On this portion of the path of totality the time of the total phase was longest, namely $3^m 45^s$. A favored location was a plateau in the neighborhood of the ancient city of Burgos, in Castile, on an elevation 2,700 feet above the sea. Here, in the middle of Spain, it was confidently expected that the weather would be favorable. On the day before the eclipse the King of Spain came to inspect the camps representing the various countries. One of the astronomers expressed to him some apprehension lest the weather on the morrow should be unfavorable. "Have confidence in the sun of Castile," His Majesty replied. However the confidence was not entirely justified. All the morning clouds were floating about, and at the time of the total phase, which took place at 1 o'clock, the sky was clear enough for successful work for but one minute out of the $3\frac{3}{4}$. At some places the results were rather better, but in others they were worse; indeed, taken together, the observations in Spain were a failure.

At Palma, in the Isle of Majorca, was a large concourse of astronomers, among them Sir Norman Lockyer and his party. Here, also, many clouds rendered the operations only partially successful. Along the remaining portion of the eclipse path, however, the circumstances were favorable. At Tripoli Professor Todd, of Amherst College, with his automatic apparatus obtained 250 photographs. He reports also that the curious phenomena known as the "shadow bands," were seen exceptionally well.

At Assouan, in Egypt, were American and English parties, and many successful photographs were taken.

A proper discussion of the mass of material obtained requires considerable time, and few results have as yet been published. It is confidently expected, however, that great additions will be made to our knowledge of the Sun.

A striking paper appeared in a recent number of the *Astro-physical Journal* on the "Figure of the Sun." In it the author, Prof. C. L. Poor, of Columbia University, gave strong evidence to show that the Sun is not spherical in shape, but that it oscillates from an oblate spheroid at the time of maximum spot-activity to a prolatespheroid when the activity is at a minimum. The variation is, of course, not great, but the result is extraordinary. Another sunspot period of eleven years should fully confirm or disprove the conclusions drawn.

At the Smithsonian Institution the study of the solar radiation and the transparency of the atmosphere has been continued. At various observatories throughout the world, especially the Yerkes, the Mendon, the South Kensington and the Potsdam, the spectro-heliograph is used on every clear day to determine the distribution of some metallic vapors in the Sun's atmosphere. Professor Hale reports good progress in the construction of the great solar observatory on Mount Wilson, California. This work is being prosecuted at the expense of the Carnegie Institution, and will undoubtedly prove of extraordinary value in our study of the Sun.

Everyone recognises that the weather is a determining factor in the economic condition of a country. At present we can safely forecast the weather's condition for twenty-four hours in advance, sometimes for a longer period. This is certainly a great achievement, and the amount of property saved by a single prediction of a great storm would pay for the maintenance of the service for a whole year. I believe in no country in the world is a higher percentage of forecasts found to be verified, and I have been pleased with the attention given to some of these matters recently in the press. I hope to see our Society materially assist in securing a proper appreciation of the value and interest of such work as the Meteorological Service unceasingly carries forward.

Now, the Sun is the ruler of our system, and it is universally admitted that if we could find out the secret of the Sun we should

have a key to unlock many of the secrets of the Earth. It is confidently hoped that by a study of solar and terrestrial phenomena, we shall ultimately be able to forecast our weather for a much longer time in advance—probably to predict the general character of an entire season.

By a study of the years from 1884 to 1904 W. N. Shaw has shown that the dryness of the autumn is the dominating element in the yield of wheat the next year. In a paper by H. I. Jensen, of the University of Sydney, N.S.W., the conclusion is reached that maximum terrestrial activity as exhibited in volcanic outbursts, earthquakes and climatic variations is coincident with maximum and minimum solar agitation. Sir Norman and Dr. W. J. S. Lockyer have also made similar researches.

It is true that the problem of finding the relation between solar activity and terrestrial phenomena is a very difficult and complicated one, but it is a matter of commanding importance, and should compel the attention of scientific men everywhere.

On September 27-29 there was a meeting at Oxford, England, of the International Union for Cooperation in Solar Research, and a series of resolutions for guidance in cooperation throughout the world were drawn up. It was pointed out that the need was urgent that all should work in harmony to cultivate the ample field.

THE PLANETS.

A year ago Prof. W. H. Pickering was triumphing in the demonstration of the correctness of his announcement, first made in 1898, that he had discovered a ninth satellite to Saturn. There are two remarkable points in the elements of its orbit, one that it is at the great distance of 8,000,000 miles from its primary (and requiring a year and a half to make a revolution), and the other that its motion is retrograde.

On the examination of several photographic plates selected from those used in determining the orbit of this satellite, still another was found. This *tenth* satellite is a very small body, about 38 miles in diameter, much smaller than any other satellite of Saturn. Its orbit is inclined at 39.1° to the ecliptic, and its eccentricity is considerable, being 0.23. Its mean distance from

the planet is 906,000 miles. Its magnitude is 17.5, and it is thus much beyond ordinary telescopes. Its period is 20.85 days.

There have also been interesting developments in the family of Jupiter. The first real celestial discovery—namely, the first revelation of Galileo's telescope made on January 7, 1610—was that Jupiter had four satellites. A fifth was seen by Barnard at the Lick Observatory in September, 1892. This one is very small and so near the planet that it is quite beyond the reach of telescopes less than 18 or 20 inches in aperture.

When the 36-inch Crossley reflector at the Lick Observatory was reconstructed, it was proposed that it be used in a search for additional satellites to the outer planets. Photographs taken on December 3, 8, 9, 10 (1904) when compared together showed the planet to be accompanied by a body of the 14th magnitude. Others on January 2, 3, 4 showed the same thing and suggested its dependence on Jupiter. On January 28 the object was easily found in the great 36-inch refractor, in the place predicted from the Crossley photographs, and a few minutes of observation showed that it had a motion of about +20" in R. A. per hour, and comparison with neighboring stars showed it to be of about the 14th magnitude. The inclination of its orbit is about 30°, and its period of revolution 250 days, or a little less, its distance 7,000,000 miles, and its diameter probably less than 100 miles.

A further examination of some of the Crossley photographs showed a much fainter object present, which on examination turned out to be a *seventh* satellite. Its inclination is about 30°, period 265 days, distance 7,300,000 miles. Its diameter is only about 35 miles, and it appears as a star of the 16th magnitude. Perrine, who was the discoverer of both satellites, suggests that the large inclination of their orbits indicates that probably neither of these bodies was originally a member of Jupiter's family, but that they have been "captured" by the giant planet.

Interesting work has also been done in comparing with each other the apparent magnitudes of the original four moons. Dr. P. Guthnick, by using a Zöllner photometer on an eleven-inch refractor, thought he could detect variations in their brightness, the variations coinciding with the periods of their revolutions about Jupiter; and his conclusion therefore was that the satellites

always present the same face to Jupiter just as our Moon does to us.

Wendell, however, of the Harvard College Observatory, obtained no evidence of variability; but it is curious to note that while his visual observations made the order of brightness of the satellites invariably to be iii, i, ii, iv, a study of the plates taken at the Cape of Good Hope Observatory by Prof. W. de Sitter reveals no variations in brightness, but their order is found invariably to be iii, ii, i, iv. Thus there seems a considerable difference in the photographic and visual estimates of the brightness of these objects.

The markings on Mars have long been of great interest to the astronomer, and ever since Schiaparelli in 1877, '79 and '81 announced the discovery of the so-called canals and their gemination, the interest has been greatly intensified. These markings are near the limit of human vision, and it has often been contended that these apparent lines are only a physiological effect. During the past year, however, some striking evidence has been obtained at the Lowell Observatory, in Arizona, at which place Mars has long been one of the chief objects for observation. On May 11 Mr. Lowell drew a sketch of the planet as seen by him. Immediately afterwards Lampland, a very capable assistant, took a series of photographs and obtained indubitable evidence of the reality of the canal-like markings. It now seems probable that Schiaparelli's views will be completely confirmed.

Dr. T. J. J. See, of the U.S. Naval Observatory, Mare Island, Cal., publishes some interesting calculations of the internal densities, pressures and moments of inertia of the principal bodies of the planetary system. From a discussion of all available data he gives for Uranus a rotation period of $10^h 6^m 40^s \cdot 32$ and an oblateness of $\frac{1}{25}$; and for Neptune a period of $12^h 50^m 53^s$, and an oblateness of $\frac{1}{40}$. He calculates that the pressure at the centre of the Earth is equal to that of 2883·152 km. of mercury, or that of a column 7,838 times as high as the Eiffel Tower. For the pressure at the Sun's centre he obtains 212 billion atmospheres. A column of mercury to produce this (if under terrestrial gravitational acceleration) would have to extend a greater distance than from the Earth to the Sun!

THE STARS.

The Harvard College Observatory continues its great task of developing the physical side of astronomy, and none of its work is of more importance than that on the stellar universe. In a fire-proof building, constructed specially for the purpose, are 180,000 photographic plates and the number is continually increasing. These furnish the only existing history of the starry heavens. An examination of these negatives leads to important discoveries every year. The curator of these photographs is Mrs. Fleming, and while examining, on August 31, the Draper Memorial plates, she discovered a new star in the constellation Aquila. In July, 1900, she had discovered a new star in this same constellation, and so the second one was known as Nova Aquilæ No. 2. On tracing its history it was found that while a close examination of plates (taken in South America) which showed all stars down to the 16th magnitude, exhibited no trace of it on August 15, yet three days later, on August 18, its magnitude was 6.5. On August 21 it had fallen to 7.5 and on August 26 it was 10. From this time on the decrease was not so rapid.

Miss Leavitt, of the same Observatory, has made some striking discoveries of variable stars in the Magellanic Cloud. Some years ago she found 57 variable stars there, and in order to study this portion of the heavens more closely, further photographs were taken at the South American station. These were examined at Cambridge, and on them 910 variables were discovered, an average of one to every 308 stars in the Cloud. The examination of 40,000 stars outside of this region gave an average of one variable in 3,300 stars.

An important addition to the data concerning the positions, inter-mutual distances and the movements of the Pleiades stars has been published in the Transactions of the Astronomical Observatory of Yale University. In 1884-6 Director Elkin triangulated these with the heliometer, but on discovering an error a new reduction was made. A comparison of these with the measurements made at Königsberg in 1840 gives evidence of motion of 9 of the 58 stars examined.

A valuable determination of the Constant of Aberration has been just published by Prof. C. L. Doolittle of the Flower

Observatory of the University of Pennsylvania. After a laborious calculation of more than 15,000 observations he reaches as his value of this important constant $20''\cdot54$. By using this quantity and the velocity of light it is possible to determine the distance of the Earth from the Sun. The value obtained by Doolittle is about $\frac{1}{300}$ greater than that agreed upon at the Paris Conference of 1896, and if we take the velocity of light as 186,330 (as found by Newcomb and Michelson), the new value of our distance from the Sun comes out to be 93,194,000 miles.

COMETS.

There were five comets discovered in 1905, the first and the third by Giacobini, of Nice, on March 26 and December 6, respectively; the second by Schaer, of Geneva, on November 17, and the other two by Mr. Lowell and Mr. Slipher when examining photographs made in November.

A METEOR'S PATH.

Some interesting results giving the actual path of a meteor observed by many people in south-west Germany have been published. The length of the path was 241 miles and the duration of its flight 9 sec. The mean velocity relative to the earth was 25.9 miles, and the absolute height above the earth's surface was 19 miles.

THE SOCIETY'S WORK DURING THE YEAR.

THE REGULAR MEETINGS.

During the year there were twenty regular meetings of the Society, and many interesting and valuable papers were read. Early in the year Mr. John A. Paterson presented a paper, admirable both on its scientific and its literary side, on "The Astronomy of Tennyson." The paper on "Personal Profit from Astronomical Studies," by the Rev. Robert Atkinson, of Chesley, whose absence from our meetings is much regretted, showed what pleasures there are for the modest student of astronomy. The subject of "Lunar Photography" was treated in a very interesting manner by Rev. Dr. Marsh, of Hamilton. He described at some length the experiments he had made in photographing the Moon, and exhibited some very successful pictures he had obtained. He is continuing his experiments and we hope to hear

from him again. An account of the recent important trans-Pacific longitude determinations by Dr. O. J. Klotz and Mr. F. W. O. Werry was given by the former. In addition to giving a statement of the scientific results, Dr. Klotz took his large audience with him on a visit to the South Sea Islands, the numerous lantern illustrations making the trip a very real one. The paper by Mr. Harvey, on "Solar Spots and Magnetic Storms in 1904," was set down for April 4, but it was not given as the lamented death of our former president occurred three days after that date. The paper, however, was so nearly completed that it can probably be put in suitable form for publication. "Some Achievements of Nineteenth Century Astronomy" were outlined by our active member from East Toronto, Mr. L. H. Graham. Our venerable and beloved friend, Mr. Andrew Elvins, who, though his body feels some of the infirmities of eighty-two years, has still the heart of youth in his love for science, had promised the Society a paper for May last on "The Cause of Weather Changes." But at that time his health was feeble, and his place was ably taken by Director Stupart. It is a great pleasure for us to have Mr. Elvins with us to-night, and to know that he has the strength to undertake the preparation of a paper to be given to the Society in March. Various subjects connected with the stars were treated in a capable manner. Mr. J. Miller Barr, of St. Catharines, gave an account of several variable stars he had discovered, Mr. A. F. Miller gave a most admirable address on Binary Stars, including in it some measurements he had made with his own equatorial, and Mr. W. B. Murson in his paper on "Stellar Classification" gave a comprehensive survey of the efforts which have been made at the Harvard College Observatory to reduce to a systematic whole the multitudinous spectroscopic observations which have been made to determine the constitution of the stellar worlds above us. Mr. J. C. Hamilton's paper on "Stellar Legends of the North American Indians" showed much research and outlined many interesting beliefs of the aborigines. The shape of the Earth and the way in which its mountains are formed were treated by Mr. J. R. Collins and Professor Coleman, respectively, and a simple explanation of the striking phenomenon known as the harvest moon was given by Mr. J. E. Maybee. The conclusions of Alfred Russell Wallace as to "Life in Other

Worlds" were combated in a very able manner in a paper by Professor Kirschmann. The total eclipse of August 30 was the subject for discussion on three evenings. On the first Mr. J. S. Plaskett, of the Dominion Observatory, Ottawa, explained the nature of the preparations being made to observe the eclipse; on the second the present speaker gave an account of our expedition to Labrador; and on the third evening a summary of results obtained all along the eclipse track was given. In addition there were two open-air meetings with the telescopes. One evening was unfavorable, but on the other the sky was clear and the attendance was very large.

SPECIAL LECTURES.

Beside the regular meetings the Society gave a series of eight public lectures in the latter part of the winter. They were held in the Chemical Building of the University, and were by Professor De Lury. I think it safe to say that never before in the history of Toronto was a course of lectures on a scientific subject so well attended. Week after week the large room was filled, the interest being sustained to the end. The average attendance was over 400. This certainly speaks well both for the study of astronomy and for the manner in which it was presented. It is proposed to continue this work, and the course this year will probably begin in February.

THE SOCIETY'S SEAL.

For a number of years the Society had under consideration the selection of a design for an official seal, and I am happy to say that during the past year the work was brought to a completion. The central portion of the design is the figure of Urania, the muse of Astronomy. This sketch is after a sculpture by Flaxman. Above her head, on a starry background, is the motto, "Quo Ducit Urania" (*i.e.*, Where Urania leads, we follow), suggested by Prof. John Fletcher, of University College. Above this again is the royal crown, and surrounding all is the name of our Society. The sketches from which the seal was cut were made by Mr. John Ellis, and I think great praise and our sincere thanks are due him for the infinite pains he took with the work.

THE UNIVERSITY AND THE SOCIETY.

At the close of my address a year ago reference was made to a proposed extension of the study of astronomy in the University and to the relation between the University and the Society. Shortly afterwards a course for graduation in Astronomy and Physics was drawn up, and on interviewing the members of the Faculty directly interested in it I found all cordially in favor of it. I would like to mention, in particular, the hearty support given by Professors Baker and De Lury to the proposed advance. As every one supported it, the Senate speedily instituted the course, and it is in operation this year. It demands considerable work in astronomical measurements and in spectrum analysis, and hearty thanks are due to Director Stupart and Mr. Blake, of the Observatory, who courteously offer all the assistance in their power.

Soon after this a committee from the Council of our Society had an interview with the Board of Trustees of the University. After expressing satisfaction with the recently-established course in Astronomy and Physics, it was suggested that the University and the Society might with advantage unite their forces. The proposition was made that the University supply suitable rooms for the Society's meetings, and also accommodation for its library and instruments, the University to be allowed to use the library and instruments. The proposal was very cordially received, and it is hoped that in the near future it will be carried out.

The University have now before them the problem of supplying proper facilities for teaching Astronomy in a thoroughly practical manner. It was at first suggested that the present main building of the Magnetic Observatory, when the Director has obtained his new quarters, be adapted for astronomical purposes. But its site encroaches too closely on the proposed site of the other buildings; and even if this were not the case it would be so completely surrounded by high walls that the horizon would be too limited for satisfactory work. It will thus be necessary to find some other site, and a good horizon can hardly be secured without going to the elevation to the north of the city.

Whatever observatory is constructed must, of course, first of all supply proper appliances for ordinary instruction. But I hope

it will not stop there. I think no department of a great University does its whole duty until it undertakes the work of research, and in Astronomy this is especially desirable. There are many valuable investigations which can be made by the careful and persistent observer. Indeed this year a useful research is being prosecuted with the 6-inch telescope of the Observatory by a graduate of the University (a member of Mr. Stupart's staff). But I have already indicated very important work on the Sun which waits to be done, and I think our University should lend assistance in the solution of some of the great outstanding problems of solar physics. To undertake this we would require a first class telescope of considerable aperture, and I beg you to commend the project to the friends of the University.

To further encourage the study of Astronomy the Society decided to institute a gold medal, and to offer a copy of it each year to the University for competition in the course in Astronomy and Physics. There is on exhibition to-night a wax model of the medal. It is the work of Messrs. P. W. Ellis & Co. of this city. We were very anxious to have the dies executed in the best possible manner, and we were glad to find a Toronto firm able to undertake the work. Messrs. Ellis are using every endeavor to produce a genuine work of art, of which we shall all be proud.

EXTENDING OUR SOCIETY.

Finally, let me refer to a project now before the Society, namely, to multiply its membership in every part of our land and thus to make it truly national in character. Chief Astronomer King, now our Honorary President, and Director Stupart, my predecessor in the presidential chair, are ready to render every possible assistance, and I see no reason why our Society should not unite in a living bond all the Astronomical interests of Canada. Our country is yet young and there is much work to do, but I am convinced that if we are all united in our efforts we shall attain results worthy of the noble subject that we study and of the noble land we live in.